The LTI Locking Shoulder Joint (SJ90) shown here has 36 locking positions in flexion and adjustable friction in abduction. The size is $2\frac{3}{8}''$ in diameter and it weighs 172 grams. The most notable difference between this shoulder joint and the previous model (SJ50) is this joint’s ability to rest in either the locked or free-swing position. Since the mounting and humeral plates are identical to the old joint, it is relatively easy to replace the old joint with this one.

The SJ90 Shoulder Joint kit consists of the shoulder joint, humeral plate, mounting plate and associated hardware (including two sets of mounting screws), Loctite 222 threadlocker and 2 hex wrenches. An optional mechanical remote release lever or an electric lock release can be added to make it more convenient for the user to activate the lock. Alternatively, a modified Sierra Nudge Control is available for chin operation.

The shoulder joint is shipped assembled with two flat-head screws holding the backing plate in place. There is no need to remove these screws. Keep this assembly together to avoid problems! Removing this plate frees the locking ring and reassembling this ring and the associated plunger pins can be difficult. Additionally, the locking ring could be installed backwards causing the joint not to operate.

The LTI Locking Shoulder Joint (SJ90) is a new design that replaces the previous LTI-Collier Locking Shoulder Joint (SJ50). This new joint has many features to improve performance and longevity. Steel locking components have replaced aluminum, ball bearings have replaced bushings and the friction abduction adjustment has been modified to provide greater clamping force and more adjustment. The lock/unlock is now an “alternating” mechanism, so each time the slider is pulled, the lock state changes from locked to unlocked or visa versa. The release can be actuated manually by any of three devices: 1) a knob on the slider, 2) a remote release lever mounted on the socket, or 3) a chin nudge control. It can also be actuated with an optional electric lock release. This joint is supplied as an exoskeletal set-up with a humeral plate, however an optional endoskeletal adapter kit is available to convert the joint. A 3-spoke mounting plate is also available for additional “structure” for use with test sockets or small X-frame sockets.
Shoulder Joint must be mounted to a flat surface with adequate structural support. If the surface is not flat, it can deform the backing plate, resulting in excess friction in the joint and unsatisfactory operation. The structure is important because of the considerable force on the shoulder joint. Poor mounting will likely result in unwanted movement and possible failure. For proper mounting, drill (#26 bit) through the socket, apply Loctite sparingly and use all 10 flat-head screws provided (see mounting instructions, pg 8).

The Shoulder Joint shown mounted to an X-frame socket. The remote actuator lever is mounted in a convenient place for the user to reach and the path of the Bowden cable is relatively straight with no sharp bends or unnecessary turns that could increase friction and make it difficult to operate. Generally, the actuator is positioned below the joint to conceal it and to make it convenient to route the Bowden cable.

**Remote Release Levers** - are available for right- and left-hand mounting (Bowden cable exits right or left – right shown here). These are provided with a mounting plate to secure them to the front of the socket. This plate can be removed and the release lever mounted from the back using the threaded inserts (M3 X 0.5 metric thread) in the housing. The new Shoulder Joint requires spring-loaded release levers rather than the two-position levers used previous with the LIT-Collier Shoulder Joint.

**Nudge Control** - An alternative to the remote release lever is the Sierra Nudge Control shown to the left. This is generally used as a chin-nudge lever rather than hand-operated release. It can be mounted from the front with the mounting plate provided or from behind by removing the mounting plate and using the two 6-32 flat-head screws provided.
Incorrect Cable Routing - Avoid routing Bowden cable through sharp and unnecessary bends which can increase the friction in the system and make it difficult for the user to operate (as shown to the left). Also try to have the cable approach the end points straight-on.

Correct Cable Routing - Relatively straight runs or broad sweeping arcs are best for routing Bowden cables. Additionally, the ends of the Bowden cable (at the release lever and near the shoulder joint) should align with the two end points. Avoid any sudden or sharp changes in direction at these end points.

Clamping the Bowden Cable - When setting up the Bowden cable and securing it at the shoulder joint end, leave two coils of the shroud exposed on the shoulder joint side of the clamp as shown here. This will center the spring against the clamp. Too few coils will allow the return spring to move off-center. Too many coils exposed may prevent the puller from traveling far enough to activate the alternate mechanism.

Remove slack in cable - To assure that the adjustment is correct, pull firmly on the cable at the shoulder joint end to remove any slack. If left slack the locking release mechanism may not work properly. The alternating mechanism requires almost ½” of travel. Since these release levers have a maximum travel of just over ½” (0.54”) it is critical that all of their travel be used effectively. Install the 1” long coil spring over the cable and thread the cable through the block.
Removing Cable Slack - With the Bowden cable properly routed and ends secured, loosen the set screw on the puller and pull the cable end again to remove any slack, then push the puller block toward the shoulder joint as shown here.

Securing the Cable - With the alternating release mechanism in the “locked position” or fully extended toward the shoulder joint and continued tension on the cable end, apply pressure to the puller (as shown) and tighten the set screw with the hex wrench provided (0.05”). This will enable the shoulder joint to lock securely and not “back out” under load.

Unlocked Position - When properly set-up, the puller rests in one of two positions. The unlocked or “free swing” resting position as shown here. In this case the spring is partially compressed and the locking pins in the shoulder joint are disengaged allowing the joint to move freely.

Locked Position - The correct “locked position” is shown here. The puller must travel fully toward the shoulder joint to lock properly. The gap between the shoulder joint and the release mechanism should be about 0.015”. To test this, if more than 3 thicknesses of paper can be inserted here, then the release mechanism should be readjusted. Back out the set screw, and push the puller block toward the shoulder joint again, then re-tighten the set screw.
When possible, it is best to pass the prosthetic wiring through the center hole provided in the shoulder joint (as shown here). These wires can then pass through the channel of the new yoke plate as shown below or can simply run down the medial side of the humeral joint and into the humeral section. It is also wise to protect the wiring with a chafing sheath as shown here. The humeral plate can be hinged either at the top or bottom of the joint, whichever is more convenient and is more anatomically correct.

**New Yoke Plate** – The latest* shoulder joints are supplied with a new Yoke Plate that has a channel for routing wires distally to the Humeral Plate and uses (2) set screws rather than spring pins to attach the Yoke to the hinge pin. The Yoke has also been further strengthened to enable greater clamping force of the abduction joint, thus providing more friction.

* 8/2/11

**Yoke Plate Set Screws** – Since both the Yoke and abduction hinge pin are now threaded, it is important to properly align these when installing the two $\frac{3}{32}$” hex-head set screws. These components are marked to indicate the proper alignment (see image on left). Once aligned, apply Loctite 222 threadlocker to the $\frac{3}{32}$” hex-head set screws and install them as shown.

* 8/2/11

**Rotation Limit Stops** – To prevent the shoulder joint from rotating more than 360 degrees, and possibly damaging cables that cross the joint, a new limit stop has been provided. This allows the joint to rotate approximately 270 degrees. The $\frac{1}{16}$” hex-head screw in the center of the joint can be removed and relocated to change the position of the center stop. There are 6 possible locations, 60° apart. For some patients, the new stop may be used to limit shoulder extension.

* 8/2/11
Abduction Friction - friction on the abduction joint is adjusted with a hex-head cap screw at the Yoke clamp, using the $\frac{5}{32}$” Allen wrench provided. This is a modified (head diameter reduced to 0.28” OD) cap screw and cannot be replaced with an off-the-shelf fastener. The Humeral Lamination Plate is attached to the Yoke with six M3 x 0.5, 8 mm long Phillips pan head sst screws (3) shown to the left. These should be installed with Loctite 222 (provided).

Preferred orientation - of the Humeral Plate is shown to the left. The bend at the top creates a natural shoulder line and moves the humeral section of the prosthesis away from the trunk, thus making it easier to clear the socket. Additionally, with the bent plate, the user can internally rotate 15° toward the body mid-line when the upper arm is straight ahead. If you prefer a straight line, then cut off the bent end of the Humeral Plate and mount the straight end to the Yoke.

Endoskeletal Conversion Kit (SJ62) - The LTI Locking Shoulder Joint can be converted to an endoskeletal system with a humeral clamp conversion kit (SJ62). The exoskeletal Humeral Plate (SJ61) is removed and the endoskeletal clamp installed in its place. This kit provides a clamp and 20mm tube which easily couples with the distal endoskeletal components (compatible with the Otto Bock 20mm endoskeletal components).

### Shoulder Joint Fasteners

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
<th>Description</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>M3 x 0.5, 20mm long flat head screws</td>
<td>Mounting shoulder joint to a thin socket</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>M3 x 0.5, 30mm long flat head screws</td>
<td>Mounting shoulder joint to a thick socket</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>M3 x 0.5, 8mm long Phillips pan head screws</td>
<td>Humeral plate-to yoke attachment</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>$\frac{3}{16}$” x $\frac{5}{8}$” long hex-head set screws</td>
<td>Yoke-pin assembly</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>Modified 10-32 x $\frac{5}{8}$” hex-head cap screw</td>
<td>Yoke clamp for abduction friction adjustment</td>
</tr>
</tbody>
</table>

LTI  Liberating Technologies, Inc.
325 Hopping Brook Road, Suite A, Holliston, MA  01746-1456  Phone 508-893-6363  FAX  508-893-9966
www.liberatingtech.com
Electric Lock Actuator

**Electric Lock Shoulder Joints (SJ91 & SJ92)**
The LTI Locking Shoulder Joint can be operated by an electric lock actuator. This is particularly useful for bilateral upper-limb amputees or people who have difficulty operating a mechanical lock actuator. The Locking Shoulder Joint can be purchased with the Electric Lock installed (shown here). One version is for use with powered elbows like the Boston Digital Arm and the other version is operated by a simple rocker switch.

**Electric Lock Actuator Kits (SJ75 & SJ76) –**
Existing LTI Locking Shoulder Joints can be converted to the Electric Lock version with one of the Electric Lock Actuator Kits. These kits are bolt-on replacements for the standard mounting plate and existing Locking Shoulder Joints can be upgraded by removing the standard mounting plate and substituting this kit.

**Profile** - The LTI Locking Shoulder Joint with the Electric Lock Actuator retains the same low-profile as the joint alone. The Electric Lock mounts directly below the joint so it can be easily concealed, thus not affecting the cosmeses. Wires from the Electric Lock can be routed on the surface of the socket to the rocker switch and power can be brought from the prosthesis through the shoulder joint.

**Control Options** - The Electric Lock actuator basically alternates between lock and unlock. A simple rocker switch (OB 9x25) enables the user to lock and unlock the joint. The Electric Lock Actuator actually arms and disarms the locking mechanism. Once armed, the joint automatically locks as it moves past a locking position. This means that the user does not need to have the lock properly aligned to lock it and the actuator does not have to overcome the resistance of a load on the joint to unlock it.
Mounting the Shoulder Joint

Create room for the Mounting Plate. Use a little plaster to position the Mounting Plate on the patient’s plaster model. Check the plate orientation by placing the joint over the Mounting Plate. Then double check the vertical lines transferred from the cast to the model. Usually it is best to position the Mounting Plate in a vertical plane. Pull the check socket over the mounted plate. Afterward clean off the plate for use in mounting the joint.

Create a flat mounting surface on the socket. If you thermoform the check socket, place a flat plate over the area outside the mounting plate and press firmly to create a flat mounting surface 2\(\frac{3}{8}\) inches (60mm) in diameter. If you have overlooked this step, you can shim the surface with 5-minute epoxy. Coat the flat plate you place over the surface with wax to release the epoxy. When doing a laminated socket, use the flat plate technique over the PVA bag.

Drill two mounting holes. Place the Mounting Plate in the pocket created inside the check socket. You need to drill two holes 180° apart using the holes in the plate as a template. Before drilling place the joint assembly where it will go and select an angle for the first two holes that best suits both cosmesis and the later routing of the release cable. Use a 3mm metric drill bit or a No. 31 (inch) bit. Use of a larger drill is not recommended, because the joint will be unstable.

Test the mounting of the joint on the socket. Flat head screws have been provided in two lengths. Usually you will need the long M3x0.5, 30mm screws for attaching to a thick check socket (>“) and the short 20mm screws for the thinner (<“) definitive socket. Mount the joint initially with just 2 screws. This permits you to study the orientation of the unlock mechanism and to consider how you will want to route the Bowden cable. It is not too late to change the angle.

Add the remaining screws. Place the 3mm screws in the two holes and then drill the other eight holes. We suggest rotating the plate and drilling two more holes for a total of 12. You will only use 10, but with 12 holes you can change the mounting angle by 30° if necessary for better cable alignment. Select the appropriate (10) mounting screws – two lengths are provided. Insert the longer mounting screws into the 10 holes in the socket and measure the lengths of the protruding screws. The protruding portion of the screws outside the socket must be longer than \(\frac{5}{16}\) (8 mm), but shorter than \(\frac{9}{16}\)” (14 mm). If they are too long, replace them with the shorter screws and repeat this measurement. Finally, after mounting the shoulder joint itself, check to make sure that these mounting screws do not interfere with the rotating elements in the shoulder joint, then tighten them in place. If the joint lock/unlock does not operate properly, it is likely that the mounting surface is not flat, thus causing the puller to bind. If this occurs, remove the joint and modify the socket to create a flat mounting surface. Repeat this process until the joint operates properly, then remove one screw at a time and apply a small amount of Loctite 222 (provided) to the end of the screw threads and tighten all of the mounting screws. To route the wires through the center of the joint, drill a 9/16 inch (14mm) hole in the center of the mounting area.

Caution!

Do not attempt to disassemble the shoulder joint – this will void the warranty.